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Shinagawa

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(54) **FUEL VAPOR PROCESSING APPARATUS**

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F02M 35/02 (2006.01)
F02M 25/08 (2006.01)

(52) **U.S. Cl.**
CPC ***F02M 35/0218*** (2013.01); ***F02M 25/0854*** (2013.01)

(58) **Field of Classification Search**
USPC 96/143, 131; 123/518–521
See application file for complete search history.

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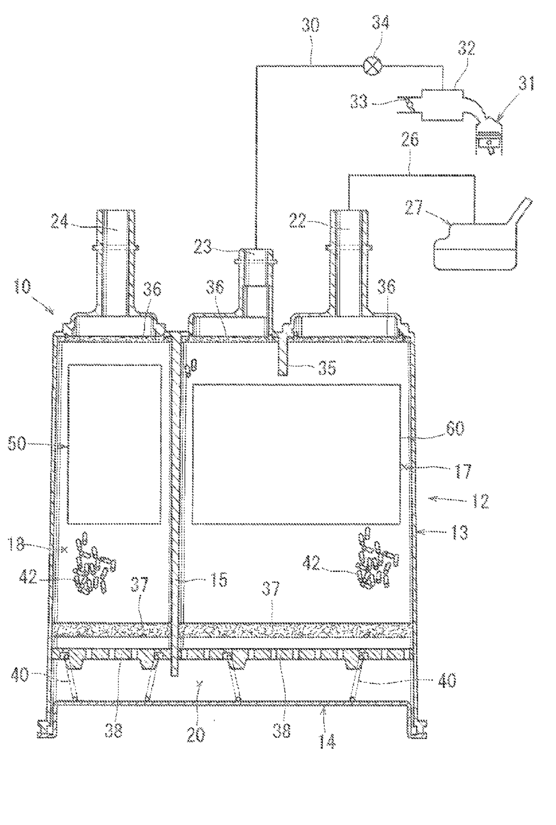
(57) **ABSTRACT**

A fuel vapor processing apparatus may include a container including an atmospheric introduction portion, through which the atmospheric air can be introduce into the container. An adsorption material may be contained in the container and configured to adsorb feel vapor and to allow the adsorbed fuel vapor to be desorbed as the atmospheric air introduced into the container flows through the adsorption material. A heater may directly or indirectly heat a part of the adsorption material located at an upstream end with respect to the flow of the atmospheric air.

9 Claims, 5 Drawing Sheets



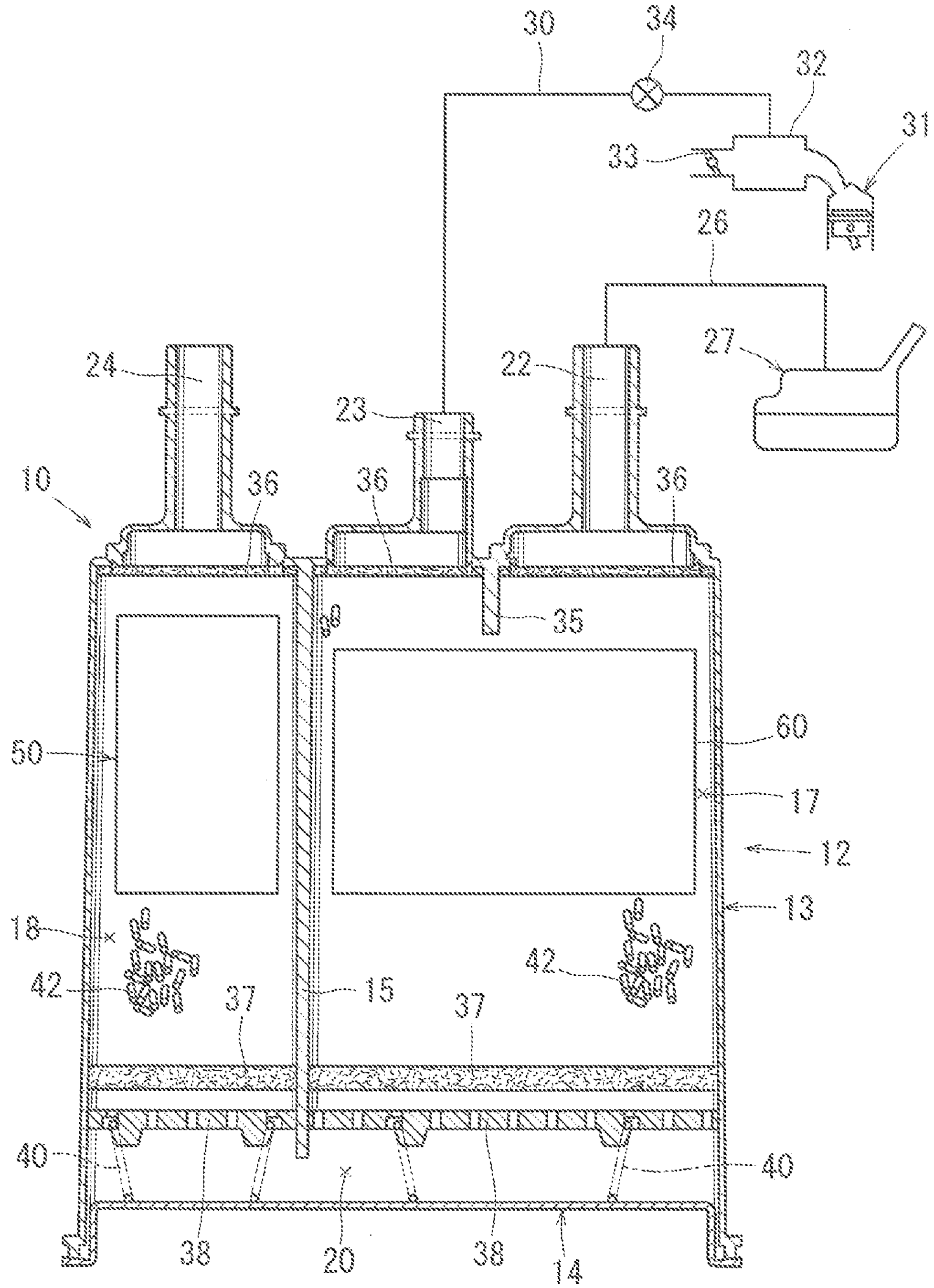

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FIG. 1

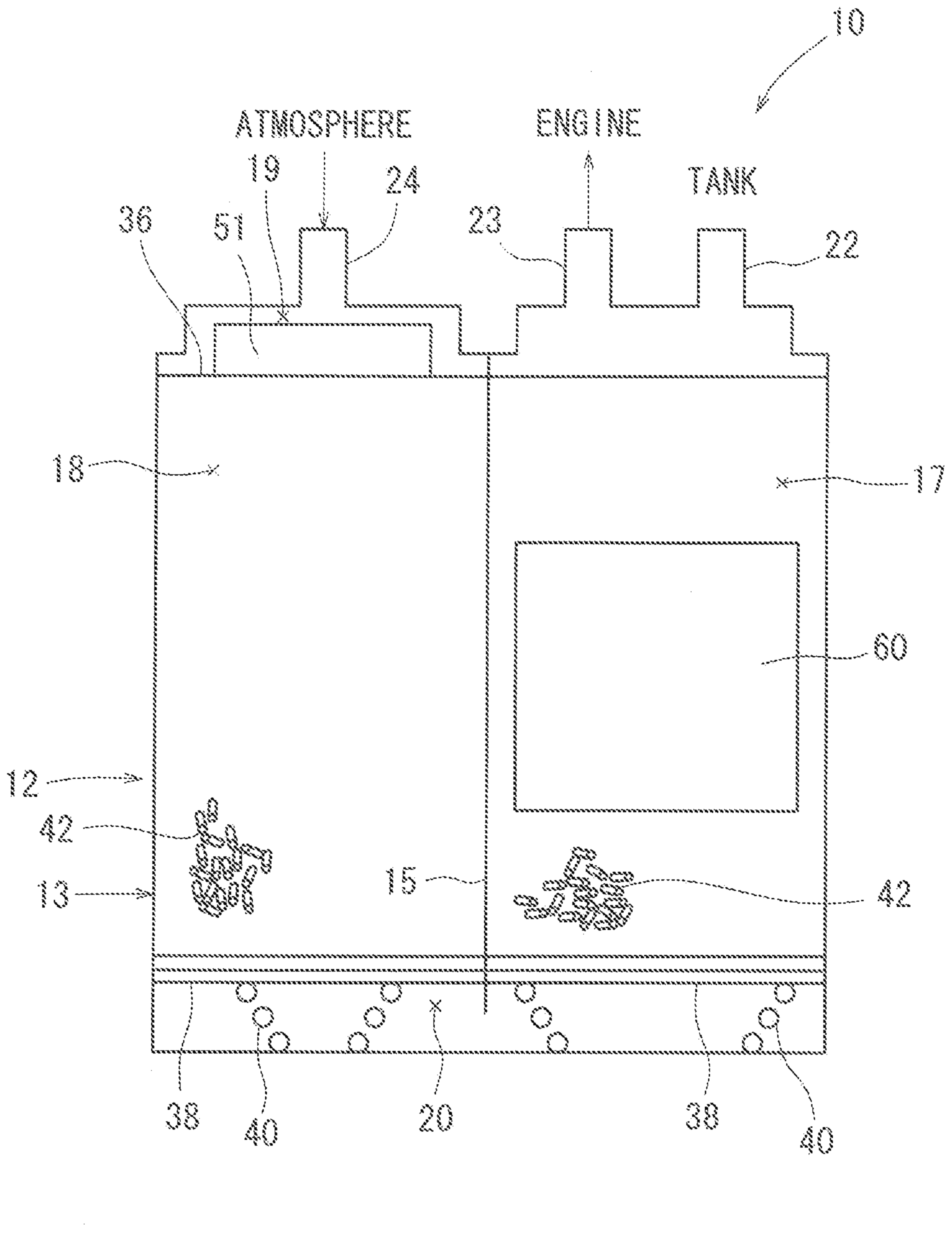
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FIG. 2

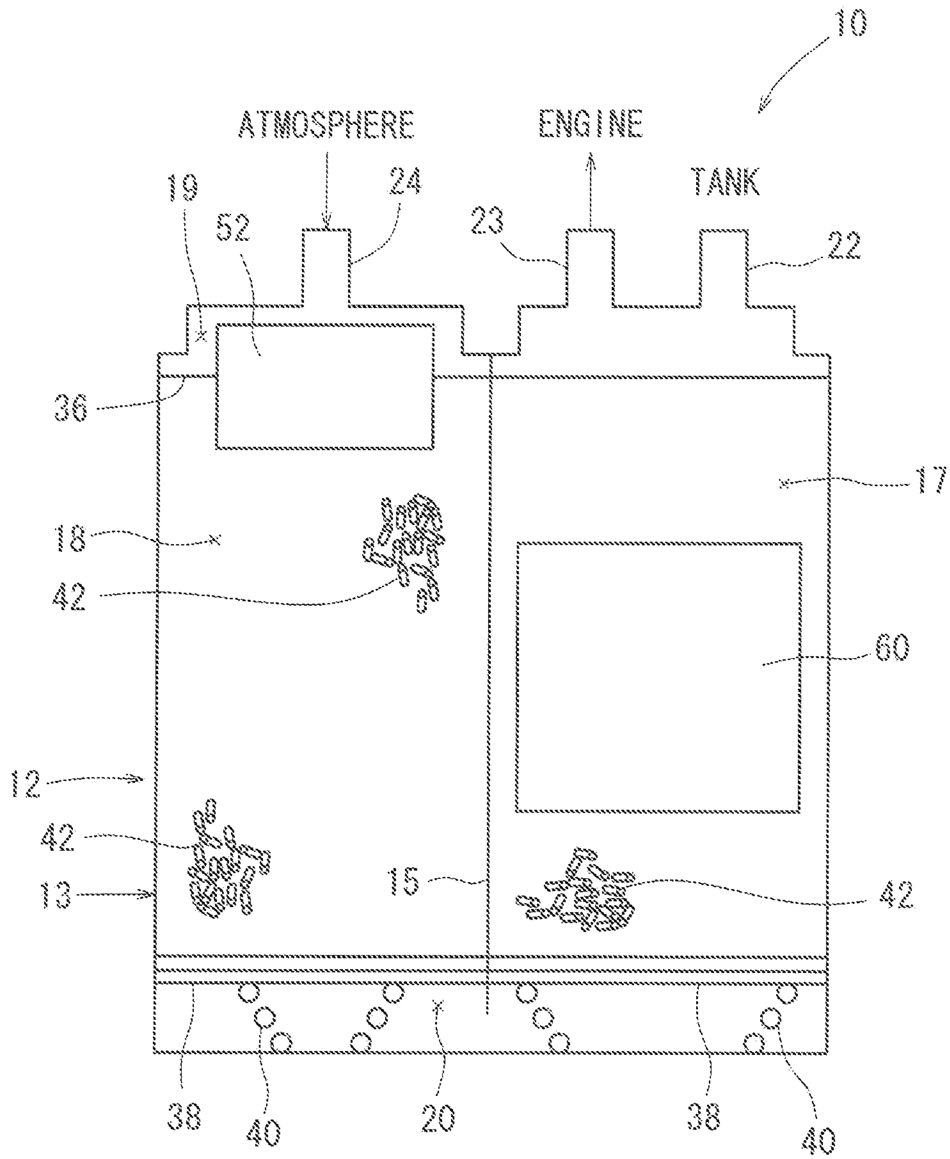
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FIG. 3

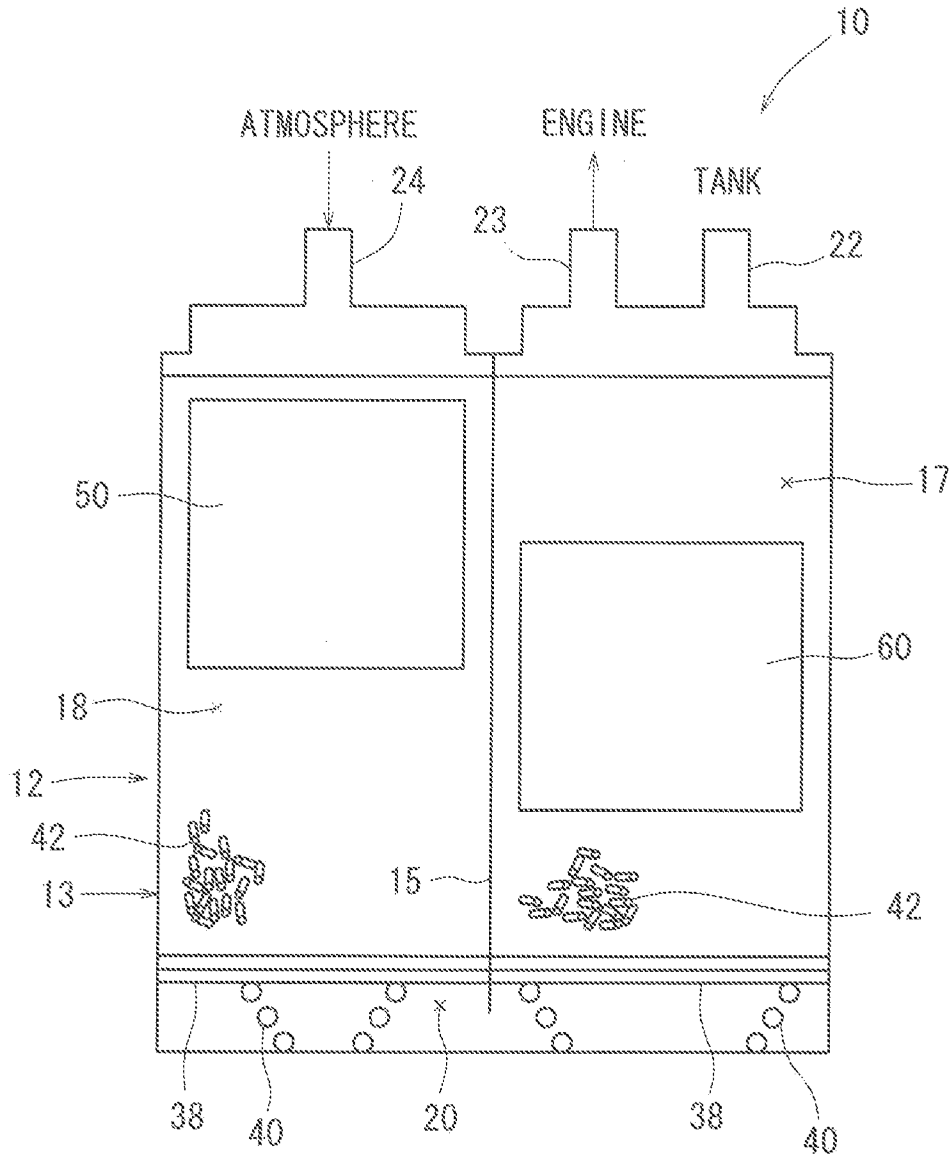

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FIG. 4

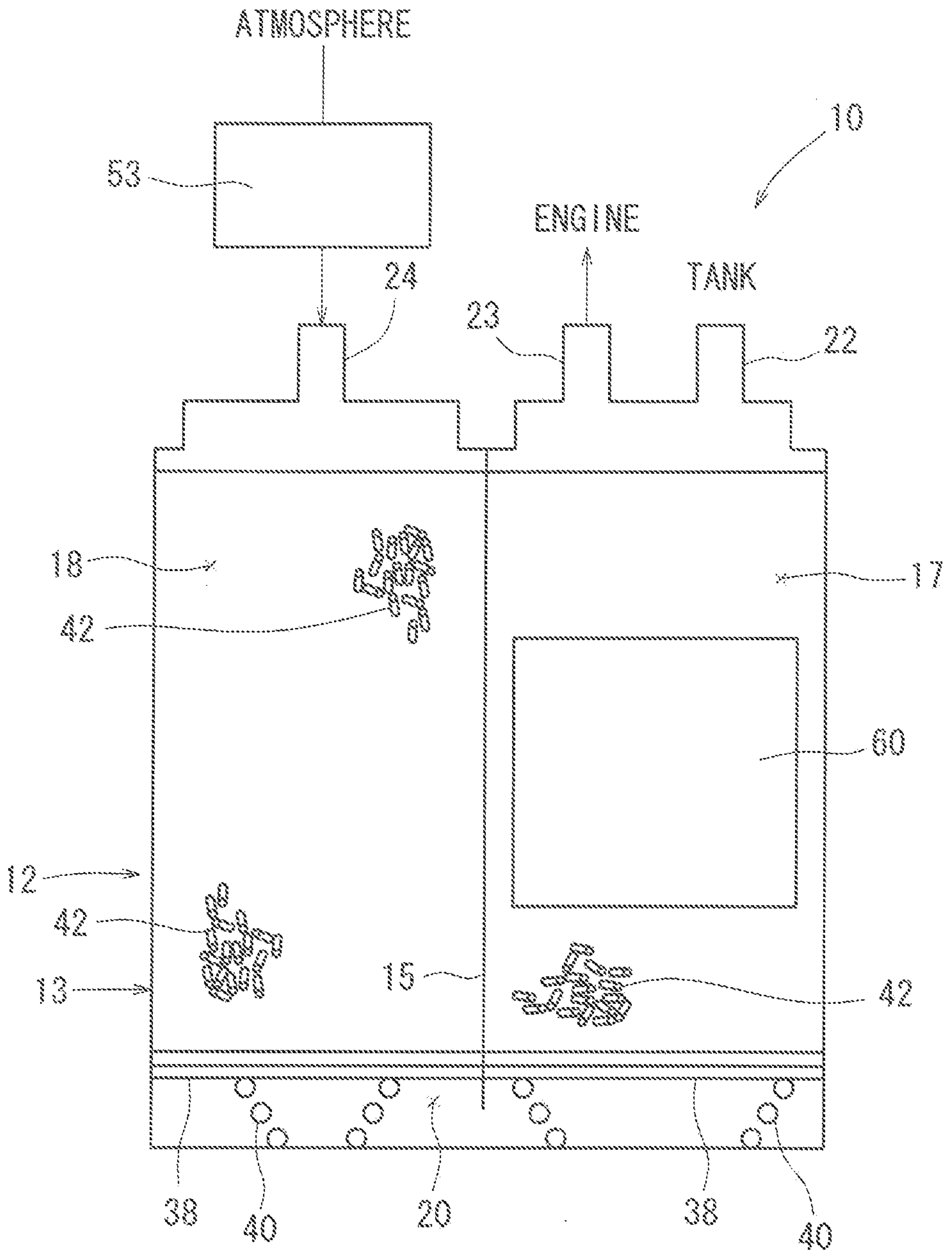
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FIG. 5

FUEL VAPOR PROCESSING APPARATUS

This application claims priority to Japanese patent application serial number 2012-126047, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

Embodiments of the present invention mainly relate to fuel vapor processing apparatus, in which fuel vapor is adsorbed by an adsorption material contained in a container, the fuel vapor adsorbed by the adsorption material is desorbed (or purge) during driving of an engine, find a heater is provided for heating the adsorption material for promoting desorption of fuel vapor.

2. Description of the Related Art

A known fuel vapor processing apparatus configured as described above is disclosed in JP-A-2002-332922. The known fuel vapor processing apparatus has a container having an internal space divided into a main adsorption chamber and an auxiliary adsorption chamber. Each of the main and auxiliary adsorption chambers has an ad sorption material contained therein and also has a heater for heating the adsorption material. The main adsorption chamber communicates with a tank port and a purge port. The tank port is connected to a fuel tank that may produce fuel vapor. The purge port communicates with an intake pipe of an engine. The auxiliary adsorption chamber communicates with an atmospheric port for introduction of the atmospheric air. The tank port and the purge port communicating with the main adsorption chamber are positioned adjacent to each other. One side of the main adsorption chamber positioned further from the tank port and the purge port communicates with one side of the auxiliary chamber positioned further from the atmospheric port.

Fuel vapor produced within the fuel tank may enter the main adsorption chamber via the tank port and may be adsorbed by the adsorption material contained in the main adsorption chamber. Apart of the fuel vapor that has not been adsorbed by the adsorption material of the main adsorption chamber may flow from the main adsorption chamber into the auxiliary adsorption chamber and may be adsorbed by the adsorption material contained in the auxiliary adsorption chamber. As the engine is driven, the air may be drawn from, within the container into the engine via the purge port, so that air may flow into the container. In this way, the fuel vapor may be desorbed from the adsorption materials. As she fuel vapor is desorbed from the adsorption materials, the adsorption materials may be cooled to cause reduction in the adsorption ability. However, the heat of the heaters may inhibit such cooling of the adsorption materials.

After the engine has been stopped, desorption of fuel vapor by the flow of air may not occur. However, in this state, it may be necessary to inhibit fuel vapor that has been once adsorbed by the adsorption materials from being released to the atmosphere. To do this, it may be necessary to reduce in advance at least the fuel vapor adsorbed by a part of the adsorption material positioned near the atmospheric air introduction port. In order to enable this reduction, it may be necessary to design the heater to have a large heating capacity for promoting desorption. However, making the heating capacity larger is not preferable because the energy consumption may be increased.

Therefore, there has been a need in the art for a fuel vapor processing apparatus that can increase the fuel vapor desorption ability of a part of the adsorption material positioned nearer to the atmospheric air introduction, portion without need of increasing the heating capacity of the heater.

SUMMARY OF THE INVENTION

In one aspect according to the present teachings, a fuel vapor processing apparatus may include a container including an atmospheric introduction portion, through which the atmospheric air can be introduce into the container. An adsorption, material may be contained in the container and configured to adsorb fuel vapor and to allow the adsorbed fuel vapor to be desorbed as the atmospheric air introduced into the container flows through the adsorption material. A heater may directly or indirectly heat a part of the adsorption material located at an upstream end with respect to the flow of the atmospheric air.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic sectional view of a fuel vapor processing system incorporating a fuel vapor processing apparatus according to a first embodiment;

FIG. **2** is a schematic sectional view of a fuel vapor processing apparatus showing arrangement of heaters according to a second embodiment:

FIG. **3** is a schematic sectional view of a fuel vapor processing apparatus showing arrangement of heaters according to a third embodiment;

FIG. **4** is a schematic sectional view of a fuel vapor processing apparatus showing arrangement of heaters according to a fourth embodiment; and

FIG. **5** is a schematic sectional view of a fuel vapor processing apparatus showing arrangement of heaters according to a fifth embodiment.

DETAILED DESCRIPTION OF THE INVENTION

Each of the additional features and teachings disclosed above and below may be utilized separately or in conjunction with other features and teachings to provide improved fuel vapor processing apparatus. Representative examples of the present invention, which examples utilize many of these additional features and teachings both separately and in conjunction with one another, will now be described in detail with reference to the attached drawings. This detailed description is merely intended to teach a person of skill in the art further details for practicing preferred aspects of the present teachings and is not intended to limit the scope of the invention. Only the claims define the scope of the claimed invention. Therefore, combinations of features and steps disclosed in the following detailed description may not be necessary to practice the invention in the broadest sense, and are instead taught merely to particularly describe representative examples of the invention. Moreover, various features of the representative examples and the dependent claims may be combined in ways that are not specifically enumerated in order to provide additional useful examples of the present teachings. Various examples will now be described with reference to the drawings.

In one embodiment, a fuel vapor processing apparatus may include a container including an atmospheric air introduction portion, through which the atmospheric air is introduce into the container. An adsorption material may be contained in the container and configured to adsorb fuel vapor and to allow the adsorbed fuel vapor to be desorbed from the adsorption material as the atmospheric air introduced into the container flows through the adsorption material. A heater may be configured to heat the adsorption material for promoting desorption of fuel vapor. The adsorption material heated by the heater may have such a temperature distribution that a temperature of a part of the adsorption material located nearer to tire atmospheric air introduction portion of the container is higher than a temperature of the remaining part of the adsorption material.

With this arrangement, it is possible to reduce the amount of fuel vapor that may remain at the pan of the adsorption material located nearer to the atmospheric air introduction portion, without need of increase of the energy consumption of the heater as a whole. Therefore, it is possible to inhibit fuel vapor from being released from the adsorption material and discharged to the atmosphere during the time when the desorption process is not performed, for example, after stopping of an engine.

The container may further include a connecting portion for connection with an intake pipe of an engine. The adsorption material may include a first portion located nearer to the atmospheric air introduction portion of the container and a second portion located nearer to the connecting portion of the container. The heater may include a first heater configured to heat the first portion and a second heater configured to heat the second portion. A heating value of the first heater may be larger than a heating value of the second heater.

By providing two heaters, i.e., the first and second heaters, it may be possible to easily control the temperature of the adsorption material such that the temperature of a part of the adsorption material located nearer to the atmospheric air introduction portion of the container is higher than the temperature of the remaining pan of the adsorption material.

The first heater may be located within a space defined in the container at a position between the atmospheric air introduction portion and the adsorption material. With this arrangement, the first heater can be arranged regardless of the configuration the adsorption material. Therefore, the construction of the first heater can be simplified. In addition, the first heater may directly heat the air that may flow through the adsorption material daring the fuel vapor desorption process. Although the adsorption material may be cooled to cause reduction in the desorption efficiency as the fuel vapor is desorbed from the adsorption material, the heat of the first heater applied to the atmospheric air may inhibit such cooling of the adsorption material.

In another arrangement, the first heater may extend between the space and the adsorption material. Also with this arrangement, the atmospheric air may be directly heated by a portion of the first heater positioned within the space, and therefore, the heat of the first heater applied to the atmospheric air may inhibit cooling of the adsorption material during the desorption process. In addition, another portion of the first heater positioned at the adsorption material may directly heat the adsorption material. Therefore, the adsorption material may be quickly heated. For this reason, even in the case that the time for desorption is relatively short, desorption of fuel vapor may be rapidly performed. In this way, the fuel vapor desorption efficiency can be reliably maintained not to be lowered.

In a further arrangement, the first heater may be disposed at one end of the adsorption member on the side of the atmospheric air introduction portion. With this arrangement, a portion of the adsorption material, which is intended to be heated to the highest temperature, can be directly quickly heated. Therefore, the fuel vapor desorption efficiency can be reliably maintained not to be lowered.

In a still further arrangement, the first heater may be arranged to heat atmospheric air that flows into the container via the atmospheric air introduction portion. For example, the first heater may be located on an outer side of the container. This arrangement is advantageous because the arrangement and the maintenance work of the first beater can be easily performed in comparison with the arrangement where the first heater is located at the adsorption member. Also, because the heat of the first heater is directly applied to the air, the heat applied to the air may inhibit cooling of the adsorption material during the desorption process.

Embodiments of the present invention will be described with reference to the drawings.

First Embodiment

Referring to FIG. **1**, there is shown a fuel vapor processing system incorporating a fuel vapor processing apparatus **10** according to a first embodiment. The fuel vapor processing apparatus **10** may be also called as a canister and may include a container **12** made of resin. The container **12** may include a rectangular tubular container body **13** and a closure member **14**. The container body **13** may have a closed front end (upper end in FIG. **1**) and an opened rear end (lower end in FIG. **1**). The closure member **14** may be configured to close the opened rear end of the container body **13**. A partition wall **15** may divide the internal space of the container body **13** into a main adsorption chamber **17** positioned on the right side and an auxiliary adsorption chamber **18** positioned on the left side. Each of the main adsorption chamber **17** and the auxiliary adsorption chamber **18** may have a rectangular tubular shape and may communicate with each other via a communication passage **20** defined within the rear end (lower end in FIG. **1**) on the inner side of the closure member **14**.

The front end (upper end in FIG. **1**) of the container body **13** may be formed with a tank port **22** and a purge port **23** each communicating with the main adsorption chamber **17**, and an atmospheric air introduction port **24** communicating with the auxiliary adsorption chamber **18**. The tank port **22** may be connected to a gaseous region within a fuel tank **27** via a fuel vapor passage **26**. The purge post **23** may be connected to as intake pipe **32** of an engine **31** via a purge passage **30**. The engine **31** may be an internal combustion engine of a vehicle, such as an automobile, in this way, the purge port **23** may serve as a connection portion for connection with the intake pipe **32**. The intake pipe **32** may have a throttle valve **33** that may control the flow rate of air supplied to the engine **31**. The purge passage **30** may be connected to the intake pipe **32** at a position on the downstream side of the throttle valve **33**. A purge valve **34** may be disposed in the purge passage **30** and may be opened and closed under the control of an engine control unit (ECU) (not shown). The atmospheric port **24** may be opened into the atmosphere and may serve as an atmospheric air introduction portion.

Front filters **36** may be respectively disposed at the front ends of the main adsorption chamber **17** and the auxiliary adsorption chamber **18**. A separation wall **35** may separate the front end portion of the main adsorption chamber **17** into a right-side region communicating with the tank port **22** and a left-side region communicating with the purge port **23**. Therefore, the front filters **36** that are two in number are respectively disposed at the right-side region and the left-side region of the front end of the main adsorption chamber **17**. Rear filters **37** may be respectively disposed at the rear ends of the main adsorption chamber **17** and the auxiliary adsorption chamber **18**. Each of the front and rear filters **36** and **37** may be formed of non-woven fabric made of resin or may be formed of urethane foam, etc. Perforated plates **38** may be respectively disposed within the main adsorption chamber **17** and the auxiliary adsorption chamber **18** at positions on the rear side (lower side in FIG. **1**) of the rear filters **37** so as to extend along the rear surfaces of the rear filters **37**. A spring **40** may be interposed between the closure member **14** and each of the perforated plates **38**. The spring **40** may be a coil spring.

Granular adsorption materials **42** may be respectively filled within the main adsorption chamber **17** and the auxiliary adsorption chamber **18**, more specifically, within spaces defined between the front filters **36** and the rear filters **37**. The granular adsorption material **42** may be activate carbon granules. For example, the activated carbon granules may be broken activated carbon or may be granulated activated carbon manufactured by a granulation process of a mixture of granular or powder activated carbon and a binder.

A first heater **50** may be disposed within the auxiliary adsorption chamber **18** and may have a heat generation element that generates heat when electrically energized. The first heater **50** may have a shape like a rectangular sheet and may be located within the auxiliary adsorption chamber **18**, more specifically, within a space defined between the front filter **36** and the rear filter **37**, such that opposite sheet surfaces of the first heater **50** face upward and downward (the front and back direction with respect to a paper surface of FIG. **1**) and the first heater **50** is embedded within the activated carbon granules of the adsorption material **42** of the auxiliary adsorption chamber **18**.

A second heater **60** may be disposed within the main adsorption chamber **17**. Similar to the first heater **50**, the second heater **60** may have a heat generation element that generates heat when electrically energized. In addition, the second heater **60** may have a shape like a rectangular sheet and may be positioned with the main adsorption chamber **17** such that the opposite surfaces of the sheet face upward and downward and the first filter **50** is embedded within the activate carbon granules of the adsorption material **42** of the main adsorption chamber **17**.

The power consumption of the first heater **50** may be set to be 15 watts, while the power consumption of the second heater **60** may be set to be 5 watts. Therefore, the heating value (heat generation amount) of the first heater **50** may be larger than that of the second heater **60**. In this way, the temperature distribution of the adsorption materials **42** heated by the first heater **50** and the second beater **60** may be set such that the temperature of the adsorption material **42** heated by the first beater **50** and located nearer to the atmospheric port **24**, through which the atmospheric an is introduced into the container **12** during the fuel vapor desorption process, is higher than the temperature of the adsorption material **42** contained in the main adsorption chamber **17** and heated by the second beater **60**.

The operation of the fuel vapor processing system incorporating the fuel vapor processing apparatus **10** will now be described with reference to FIG. **1**. The fuel vapor processing system may include the fuel vapor processing apparatus **10**, the fuel vapor passage **26**, the fuel tank **27**, the purge passage **30**, the intake pipe **32** and the purge valve **34**.

When the engine **31** is stopped, the ECU may close the purge valve **34**, so that fuel vapor produced within the fuel tank **27** may be introduced into the main adsorption chamber **17** via the fuel vapor passage **26** and the tank port **22**. The adsorption material **42** of the main adsorption chamber **17** may then adsorb the introduced fuel vapor. If the adsorption material **42** of the main adsorption chamber **17** has not adsorbed a part of the introduced fuel vapor, such a part of the introduced fuel vapor may be introduced into the auxiliary adsorption chamber **18** and may be adsorbed by the adsorption material **42** of the auxiliary adsorption chamber **18**.

During the driving operation of the engine **31**, the ECU may open the purge valve **34**, so that a negative pressure of the intake air may be applied to the purge port **23** of the container **12** of the fuel vapor processing apparatus **10**, in conjunction with this, the atmospheric air (fresh air) may be introduced into the auxiliary adsorption chamber **18** via the atmospheric port **24**. The air introduced into the auxiliary adsorption chamber **18** may desorb fuel vapor from the adsorption material **42** of the auxiliary adsorption chamber **18**. The air may be further introduced into the main adsorption chamber **17** via the communication passage **20** and may desorb fuel vapor from the adsorption material **42** of the main adsorption chamber **17**. The air containing the fuel vapor desorbed from the adsorption materials **42** may be discharged or purged into the intake pipe **32** via the purge passage **30** and may be subsequently burned in the engine **31**.

During the desorption process of fuel vapor from the adsorption materials **42** of the auxiliary adsorption chamber **18** and the main adsorption chamber **17**, a power source voltage may be applied to the heat generation elements of the first heater **50** and the second heater **60** via the ECU, so that the first and second heaters **50** and **60** generate heat. The heat generated by the first and second heaters **50** and **60** may be radiated to the adsorption materials **42** positioned around these heaters **50** and **60**. Then, the fuel vapor adsorbed onto the surfaces of the adsorption materials **42** may be heated. In this way, it is possible to inhibit the adsorption materials **42** from being lowered in temperature by the endothermic reaction caused, when the fuel vapor is desorbed. As a result, it is possible to improve the fuel vapor desorption efficiency and to promptly recover the adsorption ability of the adsorption materials **42**.

In addition, in this embodiment, the temperature of the adsorption material **42** located nearer to the atmospheric port **24** and heated by the first beater **50** may be higher than the temperature of the adsorption material **42** located within the main adsorption chamber **17** and heated by the second heater **60**. Therefore, without accompanying increase in the total power consumption of the first heater **50** and the second heater **60**, it is possible to inhibit the fuel vapor from being remained at the adsorption material **42** located nearer to the atmospheric port **24**. Hence, it is possible to inhibit fuel vapor adsorbed by the adsorption material **42** located nearer to the atmospheric port **24** from being discharged to the atmosphere during the desorption process performed when the engine **31** is stopped.

In one example, the sum of the power consumption of the first heater **50** and the power consumption of the second heater **60** may be set to be the same as the power consumption of the heater of the known fuel vapor processing apparatus. Because the power consumption of the first heater **50** is larger than that of the second heater **60**, it may be concerned if the thermal dose given by the second heater **60** is short. For example, if the thermal dose given by the second heater **60** is short, it may be possible that desorption of fuel vapor captured by the adsorption material **42** of the main adsorption chamber **17** is insufficient to the result that the adsorption ability of the main adsorption chamber **17** becomes lower. However, in the ease of the above embodiment, during the fuel vapor desorption process, the atmospheric air entering into the main adsorption chamber **17** via the auxiliary adsorption chamber **18** may be heated by the first heater **50** having a large power consumption. Hence, the heated atmospheric air may heat the adsorption material **42** of the main adsorption chamber **17**. In this way, the desorption efficiency of the fuel vapor captured by the adsorption material **42** of the main adsorption chamber **17** may not become insufficient.

In addition, because the first heater **50** and the second heater **60** are provided separately from each other, it is possible to easily perform the temperature control for setting the temperature of the adsorption material **42** located nearer to the atmospheric port **24** to be higher than the temperature of the adsorption material **42** located in the main adsorption chamber **17**.

Because the supply of electric power to the first heater **50** and the second heater **60** disposed within the container **12** may be performed via the ECU that may be located externally of the container **12**, the electric wiring for the supply of electric power may extend through a portion of the container **12**, which may be suitably chosen.

Second, third, fourth and fifth embodiments will now be described with reference to FIGS. **2** to **5**. The second to fifth embodiments are modifications of the first embodiment. Therefore, in FIGS. **2** to **5**, like members are given the same reference numerals as the first embodiment, and the description of these members will not be repeated.

Second Embodiment

The second embodiment is shown in FIG. **2** and is different from the first embodiment in that a first heater **51** corresponding to the first heater **50** of the first embodiment is located within a space **19** defined between the atmospheric port **24** and the adsorption material **42** of the auxiliary adsorption chamber **18**. As described previously, the filter **36** may be positioned to define the front end of the auxiliary adsorption chamber **18**. Therefore, the first heater **51** may be positioned on the side of the atmospheric port **24** of the filter **36**.

According to the second embodiment, the first heater **51** is located within the space **19** defined in the container **12**. Therefore, the first heater **51** can be arranged independently of the arrangement of the adsorption material **42** of the auxiliary adsorption chamber **18**. In addition, if is possible to simplify the construction of the first heater **51** than that of the first heater **50**. Further, because the first heater **51** can directly heat the atmospheric air that may flow through the adsorption material **42** during the fuel vapor desorption process, it is possible to minimize the drop in temperature of the adsorption materials **42**, which may be caused due to cooling by the flow of the atmospheric air through the adsorption materials **42** for desorption of fuel vapor.

When the atmospheric air does not flow into the atmospheric port **24**, fuel vapor adsorbed by the adsorption materials **42** may be naturally released with time so as to be discharged to the atmosphere via the atmospheric port **24**. However, in the second embodiment, the temperature of the adsorption material **41** becomes the highest at a front end part of the adsorption material **42**, which is positioned nearer to the first heater **51** and located at the front end (upper end in FIG. **2**) of the auxiliary adsorption chamber **18**, i.e., the upstream end of the flow of atmospheric air through the auxiliary adsorption chamber **18**. Hence, desorption of fuel vapor from the adsorption material **42** may be most promoted at the front end part of the adsorption material **42**. Therefore, even in the case that the time for desorption is relatively short, desorption of fuel vapor may be rapidly performed. As a result, it may be possible to minimize the fuel vapor that is remained without being desorbed. In this way, it is possible to minimize the fuel vapor that may be discharge to the atmosphere via the atmospheric port **24**.

Third Embodiment

The third embodiment is shown in FIG. **3** and is different from the first embodiment in that a first heater **52** corresponding to the first heater **50** of the first embodiment extends between a part of the adsorption material **42** of the auxiliary adsorption chamber **18** located nearer to the atmospheric port **24** and the space **19** formed in the container **12** and communicating with the atmospheric port **24**. In other words, the first heater **52** has one end embedded within the adsorption material **42** of the auxiliary adsorption chamber **18** and an opposite end positioned within the space **19**.

As described previously, the front filter **36** may be positioned at the front end of the auxiliary adsorption chamber **18**. Therefore, the first heater **52** may extend through the filter **36**. It may be also possible to configure the first heater **52** from two separate heaters positioned on opposite sides (upper and lower sides in FIG. **3**) of the filter **36**.

According to the third embodiment, a part of the first heater **52** located within the space **19** may directly heat the atmospheric air that flows through the adsorption materials **42**. Therefore, it is possible to minimize the drop in temperature of the adsorption materials **42**, which may be caused by the atmospheric air that cools the adsorption materials **42** as it flows for desorption of fuel vapor. In addition, another part of the first heater **52** located within a part of the adsorption material **42** at the front end (upper end in FIG. **3**) of the auxiliary adsorption chamber **18** may directly heat the adsorption material **42**. Therefore, the adsorption material **42** can be quickly heated. In this way, it is possible to maintain the excellent desorption efficiency even in the case that the time for desorption of fuel vapor is relatively short.

Furthermore, according to the third embodiment, the temperature of the adsorption material **42** becomes the highest at a front end part of the adsorption material **42**, which is positioned nearer to the first heater **52** and located at the front end (upper end in FIG. **3**) of the auxiliary adsorption chamber **18**, i.e., the upstream end of the flow of the atmospheric air through the auxiliary adsorption chamber **18**. Hence, desorption of fuel vapor from the adsorption material **42** is most promoted at the front end part of the adsorption material **42**. Therefore, even in the case that the time for desorption is relatively short, desorption of fuel vapor may be rapidly performed. As a result, it may be possible to minimize the fuel vapor that is remained without being desorbed. In this way, it is possible to minimize the fuel vapor that may be discharge to the atmosphere via the atmospheric port **24**.

Fourth Embodiment

The fourth embodiment is shown in FIG. **4** and is different from the first embodiment in that the entire first heater **50** is positioned within a front side half region, of the auxiliary adsorption chamber **18** nearer to the atmospheric port **24**.

With this arrangement, the first heater **50** can directly heat the adsorption material **42** including a front end part of the adsorption material **42** nearer to the atmospheric port **24**. Therefore, the adsorption material **42** can be quickly heated. In this way, it is possible to maintain the excellent desorption efficiency even in the case that the time for desorption of fuel vapor is relatively short.

Fifth Embodiment

The fifth embodiment is shown in FIG. **5** and is different from the first embodiment in that a first heater **53** corresponding to the first heater **50** of the first embodiment is located for heating the atmospheric air before the atmospheric air flows into the auxiliary adsorption chamber **18**. In this embodiment, the first heater **53** is located outside of the container **20**. For example, the first heater **53** may be disposed within a pipeline (not shown) that supplies the atmospheric air to the atmospheric post **24**. Alternatively, the first heater **53** may be located within the atmospheric port **24**.

According to the fifth embodiment, the first heater **53** may be mounted within an outside pipeline or may be mounted within the atmospheric port **24** from the outside. Therefore, the operation for mounting the first heater **53** and the maintenance work for the first heater **53** can be easily performed. In addition, because the heater **53** can directly heat the atmospheric air that may flow through the adsorption material **42** during the fuel vapor desorption process, it is possible to minimize the drop in temperature of the adsorption materials **42** by the atmospheric air that may cool the adsorption materials **42** as it flows for desorption of fuel vapor.

Further, the temperature of the front end part of the adsorption material **42** located at the front end (upper end in FIG. **5**) of the auxiliary adsorption chamber **18** may be the highest of the adsorption material **42**. Hence, desorption of fuel vapor from the adsorption material **42** is most promoted at the front end part of the adsorption material **42**. Therefore, even in the case that the time for desorption is relatively short, desorption of fuel vapor may be rapidly performed. As a result, it may be possible to minimize the fuel vapor that is remained without being desorbed. In this way, it is possible to minimize the fuel vapor that may be discharge to the atmosphere via the atmospheric port **24**.

Possible Modification

The above embodiments may be modified in various ways. For example, the adsorption material **42** of each of the man adsorption chamber **17** and the auxiliary adsorption chamber **18** may be divided into two or more layers. Although the heaters **50** and **60** are configured to have heat generation elements that generate heat when a power source voltage is applied, the heaters **50** and **60** may be replaced with any other type of heaters, such as hot-water heaters that do not use an electric power as an energy source. Further, each of the first and second heaters **50** and **60** of each of the above embodiments may include a plurality of separate heaters.

What is claimed is:

1. A fuel vapor processing apparatus comprising:

a container including an atmospheric introduction portion, through which atmospheric air is introduce into the container,

an adsorption material contained in the container and configured to adsorb fuel vapor and to allow the adsorbed fuel vapor to be desorbed from the adsorption material as the atmospheric air introduced into the container flows through the adsorption material; and

a heater configured to heat the adsorption material for promoting desorption of fuel vapor,

wherein the adsorption material heated by the heater has such a temperature distribution that a temperature of a part of the adsorption material located nearer to the atmospheric introduction portion of the container is higher than a temperature of the remaining part of the adsorption material;

wherein the container further includes an connecting portion for connecting with an intake pipe of an engine;

wherein the absorption material includes a first portion located nearer to the atmospheric air introduction portion of the container and a second portion located nearer to the connecting portion of the container;

wherein the heater comprises a first heater configured to heat the first portion and a second heater configured to heat the second portion; and

wherein the first heater has a higher power consumption the second heater such that the first heater is configured to generate a larger amount of heat than the second heater when both the first heater and the second heater are heating the adsorption material.

2. The fuel vapor processing apparatus according to claim **1**, wherein

the container includes a space defined between the atmosphere air introduction portion and the adsorption material; and

the first heater is located within the space.

3. The fuel vapor processing apparatus according to claim **1**, wherein:

the container includes a space defined between the atmosphere introduction portion and the adsorption material; and

the first heater extends between the space and the adsorption material.

4. The fuel vapor processing apparatus according to claim **1**, wherein the first heater is disposed at one end of the adsorption material on the side of the atmospheric air introduction portion.

5. The fuel vapor processing apparatus according to claim **1**, wherein the first heater is arranged to heat air that flows into the container via the atmospheric air introduction portion.

6. The fuel vapor processing apparatus according to claim **5**, wherein the first heater is located on an outer side of the container.

7. The fuel vapor processing apparatus according to claim **1**, wherein the first portion of the adsorption material comprises a first adsorption material, and the second portion of the adsorption material comprises a second adsorption material positioned apart from the first adsorption material.

8. The fuel vapor processing apparatus according to claim **1**, wherein the first heater and the second heater are configured to simultaneously heat the first portion and the second portion of the adsorption material for promoting desorption of fuel vapor.

9. The fuel vapor processing apparatus according to claim **1**, wherein the first heater and the second heater are configured to simultaneously heat the first portion and the second portion of the adsorption material during desorption of fuel vapor.

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